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Sample Concentration Systems for Fast Laboratory Evaluation of Sensory Materials for Chemical and Biological Agent Detection in Water

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13. ABSTRACT (Maximum 200 words)

This report summarizes the prototyping work of micro pumps with micro fluid channels for fast material evaluation of sensory materials for chemical and biological agent detection. The work conducted under this project is a six-month pilot study. The objective of the research is to help speed up the C&B sensory material research at the Army Research Laboratory in Aberdeen, Maryland. Several prototypes of the micro pumps with different fluid channels have been studied. Experiments of sample concentration with the micro pump test station have been conducted in the ARL, and demonstrated significant improvement of the response of the sensory material to various chemical agents.

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Statement of the Work

The work conducted under this project is a six-month pilot study. The objective of the research is to help speed up the C&B sensory material research at the Army Research Laboratory in Aberdeen, Maryland. Several prototypes of the micro pumps with different fluid channels have been studied. Experiments of sample concentration with the micro pump test station have been conducted in the ARL, and demonstrated significant improvement of the response of the sensory material to various chemical agents. In the meantime, we have also demonstrated the feasibility of concept micro pumps fabricated by the surface machining technology. The surface machining technology is the basic operation of semi-conductor industry, and has a potential to make miniature pumps that can be readily integrated with the electronic control circuitry.

Summary of the Results

This project is a continuation of an earlier effort to develop micro pumps for sample concentration. During this project period, we have made several prototypes of micro pumps, and have evaluated the effectiveness of sample concentration at the Army Research Laboratory in Aberdeen, Maryland.

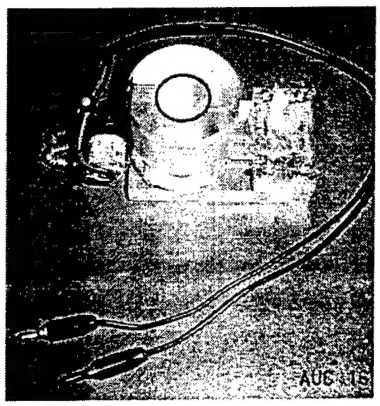

Figure 1. Desk micro pump station with sample concentration mechanism and fluid channels. The cylinder on the top of the platform is the reservoir of the chemical solution.

We made several micro pump stations with a reservoir for containing and recycling the chemical solution. The surface machining technology was used in fabrication of the systems. Power supply units have also been made in connection to the stations. A prototype pump is shown Figure 1. The fluid is pumped through a small channel in a plexiglass body, where the sample ticks coated with the C&B detecting materials developed by the researchers of ARL at Aberdeen. Three undergraduate students in the Department of Mechanical Engineering have been working on this project.

One of the micro pumps is driven by a linear solenoid powered by a PWM voltage source. The shaft of the solenoid is attached to the diaphragm, which pumps the fluid. A schematic of the micro pump is shown in Figure 2. The whole system is confined in a $2.5\times6.3\times10\text{cm}^3$ rectangular body. This choice of the dimensions was made with a consideration of a possible pocket size implementation of the chemical and biological sensors.

Figure 2. A schematic drawing of the micro pump with a linear solenoid motor.

Experiments of sample concentration with the micro pump test station have been conducted in the ARL, and demonstrated significant improvement of the response of the sensory material to various chemical agents. Figure 3 shows some results of optical reading of the C&B detection material after being exposed to the chemical agent for a fixed period of time. Since the flow over the surface of the test ticket as shown in Figure 4 is turbulent by way of the design of the fluid channel, the C&B detection material has a much higher exposure to the chemical agent, and thus has shown a significantly higher response as shown in the figure.

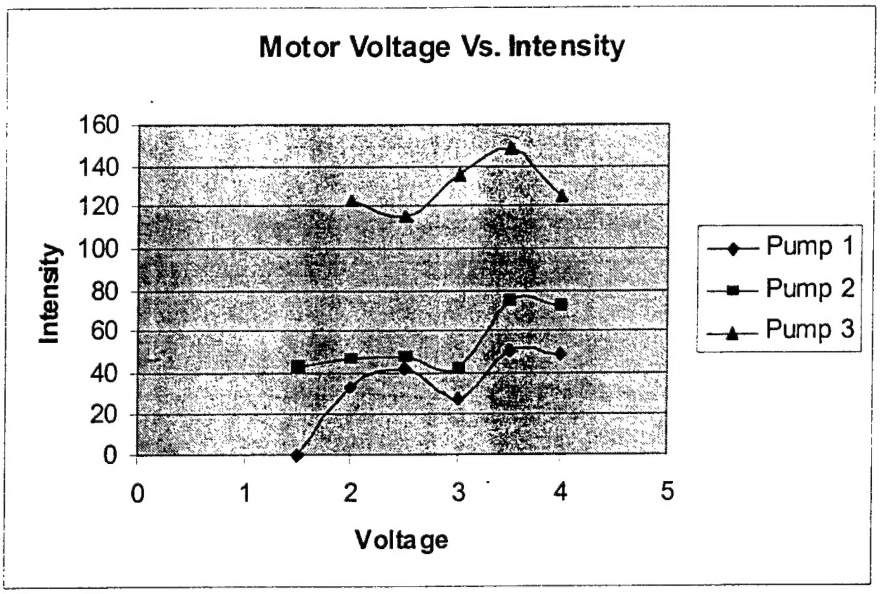

Figure 3. With 100% concentration of the chemical, the ARL researcher obtained the optical intensity reading between 600 and 700. With the solution diluted by 25 times, pump 3 with an improved fluid channel gives a maximum intensity reading 148. This represents a significant improvement of sensitivity by means of the sample concentration mechanism.

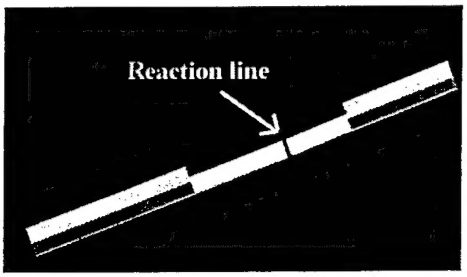

Figure 4. The ticket coated with the C&B detection material.

The work done in the past six months has helped the researchers of ARL at Aberdeen to speed up the R&D of C&B detection materials. The effort of this project can be extended to study the effectiveness of large-scale sample concentration systems for C&B detection in the water supply.

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